INTEGRATED MANAGEMENT OF LAGOON ACTIVITIES
IMOLA PROJECT II

A REPORT ON

EVALUATION OF ECONOMIC EFFICIENCY AND ENVIRONMENTAL IMPACTS OF POLYCULTURE OF GREASY GROUPER AND OYSTER IN CAGES

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PEOPLE'S COMMITTEE OF THUA THIEN HUE PROVINCE

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TABLE OF CONTENT

1. INTRODUCTION

Grouper (*Epinephelus spp*) is a common fish species which generates high economic advantage. Since 1990, grouper culture has been intensely escalating in Quang Ninh, Hai Phong, Thua Thien Hue, Phu Yen, Khanh Hoa provinces, and in others; and bringing substantial benefits to local people. In Thua Thien Hue province, grouper cage or pond culture has been initiated in some districts such as Phu Vang, Phu Loc, and Huong Tra. According to a survey carried out in May, 2004, there were 50 settled households in Con Son, Hoa Duan engaged in grouper culture; and in the coastal town of Thuan An, there were 20 households possessing between 60 and 80 cages. In the meanwhile, in village 2, Hai Duong commune, Huong Tra district, 35 small-scaled households with around from 110 to 120 cages were also acknowledged. (The Hien Huynh, 2004).

Hai Duong is situated in the South of Tam Giang Lagoon where the water salinity varies to the weather and annual rainfall and giant tiger prawn is regarded as the most popular species. However, the salinity range and sand bottom is unsuitable for giant tiger shrimp culture development. Disease and environmental pollution is a key trouble these days. Grouper is regarded as a species that may add value to economic revenue in this area. Nevertheless, the expansion of grouper culture is a great challenge due to the fingerling source unavailability and environmental pollution and disease outbreak is a consequence. Another repercussion is the failure in grouper farming business in recent years. Pollution problems and environmental diseases need to be resolved in a proper manner. Solutions may include planning the culture areas, improving the culture process and technical measures to improve seed quality. One of the answers, which reached the high accord between the international research originations is the application of polyculture in order to diminish the threat of environmental degradation, limit disease spread, and improve the cultivation efficiency (Gordin and colleagues, 1980; Folke and Kautsky, 1992; Quian, 1996). Polyculture of grouper, and other mollusc species can be viewed as an answer to avert environmental pollution and foster alternative method for shrimp culture. Fish is an apposite species to be cultured in this area.

The polyculture of grouper and oyster was carried out under the support of the IMOLA project which aimed at finding a way to safely guarantee sustainable livelihoods for people in Tam Giang lagoon, Thua Thien Hue province.

2. METHODOLOGY

2. 1. Time and location

Time: from 2/2008 to 8/2008.

Location: Hai Duong commune, Huong Tra district, Thua Thien Hue province.

2.2. Experimental arrangement

Pilot was conducted in two cages of 20 m^3/cage (4x2x2.5m), with the following formula:

Table 1. Experimental arrangement method

Type of culture	Species	Density	Seed size	Feed
Polyculture	Grouper	30 units /m^3	4g/unit	Trash fish
	Oyster	1 kg/ m	2- 3 cm	No supplementary feed
Monoculture	Grouper	30 units /m^3	4g/unit	Trash fish

Oyster and grouper seeds were collected from the nature. Oyster was hanged on rope bundles laid around the cages; the wire was 2m long (from the top to the cage bottom) to improve the water environment in the cage.

2.3. Methodology

2.3.1. Research methods on biological characteristics

The growth and survival rate was measured twice a month during the culture process. Fishes was anaesthetized with AF 1%; body length was assessed with checquered paper and the weight by scale. Fish survival was verified with the growth speed and the number of dead fishes was removed from the experiment. Oyster weight was checked by weighting ropes.

2.3.2. Methods of parameter measurement

- Temperature: Use thermometer MC Taiwan's to check twice a day at 8 AM and at 2 PM.
- Salinity: Use the refraction ATAGOD (test 1 times/ day at 2 PM).
- pH: pH measured (1 times/ day at 2 PM).

- NH_3-N: Use the Serra test NH_4/NH_3 (Germany), periodically measuring 1 time per week.
- BOD: apply methods namely BOD bottles Oxitop: place bottles in 20°C in 5 days and BOD was automatically measured when the temperature reached 20°C. BOD values were automatically recorded every 24 hours.

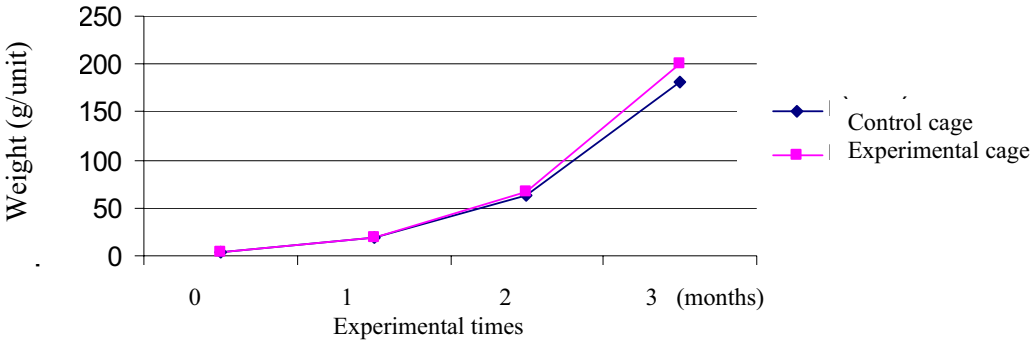
2. 4. Analyzing datas

Data was analyzed by Excel.

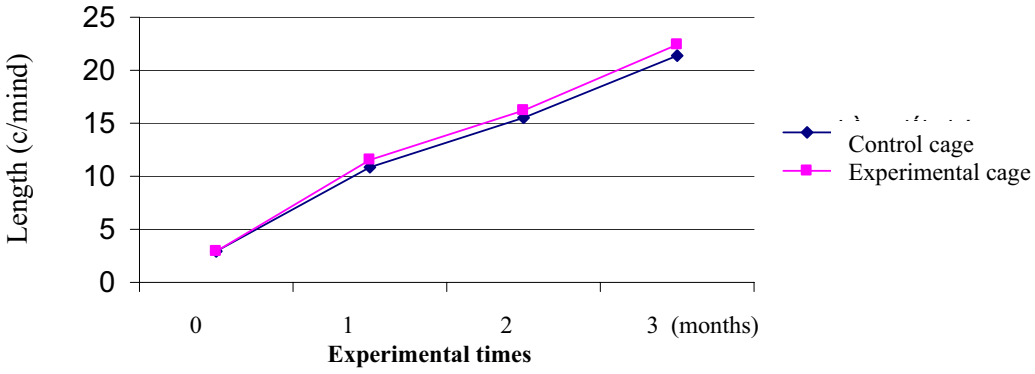
3. RESULTS

3.1. The growth speed of grouper

The growth results of grouper after 6 culture months are shown in graph 3.1 and 3.2.



Graph 3.1. The growth speed in weight of grouper during crop



Graph 3.2. The growth speed in length of grouper during crop

The graph 3.2 shows that the grouper in the cage 2 grew rapidly in weight and length.

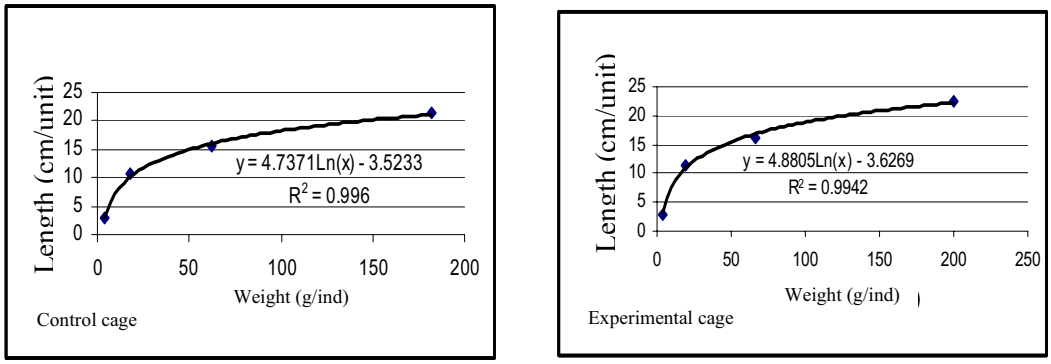
This was more clearly shown at the second and third testing. During the implementation model, the growth of the fish in the treatment cage ($W_{average}$ = 200g/unit, $L_{average}$ = 22.4 cm /unit), faster than in the control cage ($W_{average}$ = 181.81g/unit =, = $L_{average}$ 21.3 cm /unit) but the difference is insignificant in the statistical aspect (p> 0.05). Therefore, polyculture of groupers and oysters did not impact the ability of fish growth.

3.2. Relations between length and weight of grouper

Results from the monitoring of body weight and length indicated that the relation between the length and weight of grouper were presented in graph 3.3. Related equations between body length and weight are as follows:

- Control cage: y = 4.7371 Ln (x) - 3.5233 with the number of relation R2 = 0996
- Treatment cage: y = 4.8805 Ln (x) - 3.6269 with the number of relation R2 = 0.9942

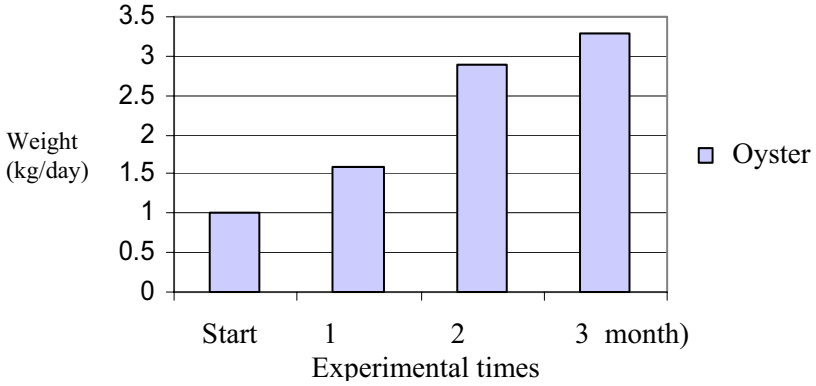
In which y is the body length (cm) and x is body weight (g). In general both treatment and control cages showed the close relation between body length and body weight (R2> 0.9).



Graph 3.3. Relations between length and weight of grouper

3.3. Results of oyster growth speed

Results of oyster growth speed after 6 culture months are shown in the graph 3.4.

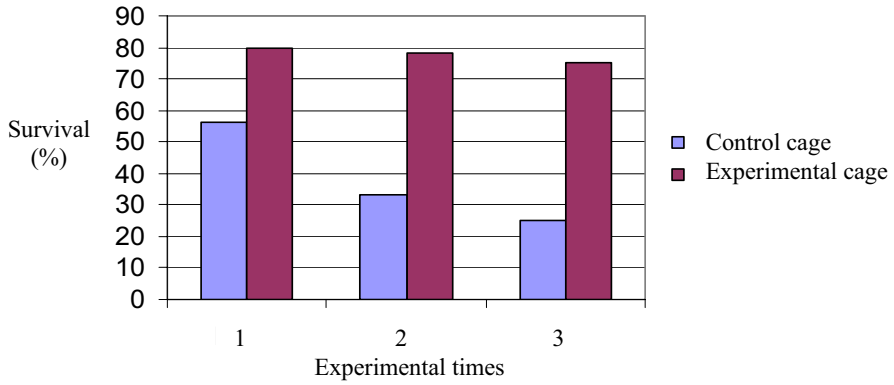


Graph 3.4. Growth speed of oyster 6 months

The graph 3.4 shows that oyster weight increased in a rapid speed. The period of the fastest growth was from the 2nd to 4th month but the culture rate increased gradually over the time. This can be explained by the strong salinity fluctuations during the culture process; in the first 2 months, the salinity was relatively low at 7 – 8 %. Later, it gradually augmented and promoted oyster growth in the next 2 months. These research results were in line with the oyster outcomes of some households in Lang Co with capacity of approximately 3-7 kg of units/ day (National Agriculture Extension Center, 2008).

3.4. Survival of grouper

The results are presented in graph 3.5 from four times of checking the survival rate.



Graph 3.5. Survival of grouper between control and experimental cage

Graph 3.5 shows that survival rate in the polyculture cage was 75 %, higher compared to that in the monoculture cage with only 25% after 6 culture months. This showed a difference in statistical aspects ($p < 0.05$). In the implementation pilot, trash fishes were applied so the pollution level was high; in addition, other harmful substances available from the environment resulted in the massive death of groupers in the control cage as sudden environmental changes occurred such as the tidal regime, salinity, temperature and so on. In the mean while, in the treatment cage, the level of pollution was reduced to the maximum by the filtering ability of oysters. This may be the reasons for the differences of the survival rate between the experimental cages. This shows that oysters had a positive influence on grouper survival rate.

A solution to maintain the environmental equilibrium and take advantage of nutrients in the shrimp farming areas nowadays is to utilize substrate in oyster culture. In the Philippines, in

the friendly aquaculture with the mangrove forest, bivalve species called *Sonneratia sp.* is cultured to trim down the harmful effects from shrimp farming.

3.5. The fluctuation of environmental parameters in cages

Results on the changes of environmental parameters in the control cage and treatment cage were presented in table 2.

Table 2. The fluctuation of environmental parameters

Criteria	***Treatment cage***	***Control cage***
DO (mg/l)	4.87 ± 0.18	4.30 ± 0.17
NH_3 (mg/l)	0	0.03 ± 0.01
Turbidity (cm)	31 ± 2.08	37 ± 1.70
BOD (mg/l)	3.4-3.8	4.5-5.7
Salinity (‰)	7 23	7 - 23
Temperature (^oC)	17 – 27	17 - 17
pH	7.7 - 8.5	7.7 - 8.8
KH (mg/l)	71.81 ± 8.35	70.86 ± 8.42

The table 2 shows that the environmental parameters were in line with the the culture species development. However, there were big differences between the two equations. It was the amount of BOD in the monoculture cage was always higher than in the polyculture cage. BOD in the polyculture cage was between 3.4-3.8, lower than in the monoculture cage (4.5-5.7). BOD in the monoculture cage was higher, combined with the quite large salinity fluctuations and temperature during the experiment process, which resulted in the massive death in the control cage. Thus, the polyculture with oyster has contributed to the organic pollution reduction.

3.6. Results of the estimated economic accounting of the polyculture pilot

After 6 experimental months, we harvested groupers and oysters in both cages; the economic inpacts of the model was shown in table 3 and 4.

Table 3. The accounting profit and economic efficiency of the experimental cage

Expenditure		**Unit**	**Quantity**	**Price unit (VND)**	**Total (VND)**
Cage preparation		-	-		200,000
Seed	Groupers	unit	600	800	480,000
	Oysters	Kg	100	10,000	1000,000
Feed		kg	500	5,000	2,500,000
Total expense					4,180,000
Total income		Grouper	120	12,000	14,400,000
		Oyster	200	10,000	2,000,000
Total pilot income			320	22,000	**16,400,000**
Profit					**12,220,000**
Income/Expense (VCR)					4.10
Profit / Expense					3.04

Table 4. The accounting profit and economic efficiency of the control cage

Expenditure		**Unit**	**Quantity**	**Price unit (VND)**	**Total (VND)**
Cage preparation		-	-		200,000
Seed	**Grouper**	ind	600	800	480,000
Feed		kg	200	5,000	1,000,000
Total expense					**1,680,000**
Total income		Grouper (kg)	35	120,000	4,200,000

Total pilot income				**4,200,000**
Profit				**2,520,000**
Income/Expense (VCR)				**2.65**
Profit / Expense				**1.52**

Economic impacts expected in table 3 and 4 shows the profit/ total expense of polyculture reached 3.04, while in the monoculture, it only reached 1:52. Also the polyculture investment costs were suitable with the capital source as well as the need to diversify the culture forms and species of local people today. Therefore the poor can get access to this culture pilot.

4. CONCLUSION AND SUGGESTION

4.1. Conclusion

- The six month experiment model shows that groupers and oysters grow and develop well. During the implementation pilot, the growth of the groupers in experimental cage ($W_{average}$ = 200g/unit, $L_{average}$ = 22.4 cm / unit) was faster than the control cage ($W_{average}$ = 181.81g/unit, = $L_{average}$ 21.3 cm / ind) but the difference is insignificant in statiscal aspects ($p > 0.05$).
- There is a vivid variation in the grouper survival rate between the treatment cage (75%), compared to 25% of the control cage ($p < 0.05$). Most have a positive influence on survival of grouper during the culture time.
- Polyculture with oysters can reduce BOD5 in grouper cage.
- Based on the economic impacts, the pilot is suitable for local people.

4.2. Suggestions

- Measuring other environmental parameters such as COD and microorganism to evaluate more precisely on the ability to cut down environmental pollution caused by this pilot
- Continue to expand this pilot around the river mouth areas.

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ANNEX. RAW DATA

1. Change of some environmental parameters

Grouper and oyster cage

Checking time	*DO*	*NH3*	*BOD*	*Salinity*	*Transparency*	*Temperature*	*pH*	*KH*
Time 1	4.7	0.0	3.4	7	28	17	7.8	60
Time 2	4.9	0.0	-	10	32	19	8.5	65
Time 3	4.7	0.0	-	12	33	21	8.5	66
Time 4	5.1	0.0	3.5	15	28	21	8.0	66
Time 5	5.0	0.0	-	15	30	25	8.1	75
Time 6	5.1	0.0	-	17	33	27	7.7	73
Time 7	4.7	0.0	-	23	32	20	8.5	77
Time 8	4.8	0.0	3.8	20	32	23	8.3	86

Grouper cage

2. Growth rate of grouper

Length:

- Polyculture pilot:

Checking time	*DO*	*NH3*	*BOD*	*Salinity*	*Transparency*	*Temperature*	*pH*	*KH*
Time 1	4.1	0.00	4.5	7	34	17	7.8	60
Time 2	4.1	0.00	-	10	34	19	8.5	65
Time 3	4.4	0.00	-	12	37	21	8.5	66
Time 4	4.3	0.03	5.5	15	38	21	8	66
Time 5	4.3	0.04	-	15	39	25	8.1	75
Time 6	4.2	0.04	-	17	39	27	7.7	73
Time 7	4.6	0.04	-	23	37	20	8.5	75
Time 8	4.3	0.05	5.7	20	38	23	8.8	86

- Monoculture pilot

Checking time	Beginning	Time 1	Time 2	Time 3
1	2.5	9	16	24
2	2.3	11	17	25
3	2.6	13	18	20
4	2.2	11	14	23
5	2.3	8	15	19
6	2.5	14	13	19
7	2.5	13	15	23
8	2.4	9	16	25
9	2.8	10	17	18
10	2.8	12	13	22

Weight:

- Polyculture pilot:

Checking time	Beginning	Time 1	Time 2	Time 3
1	1.0	18	61	190
2	1.0	23	71	195
3	0.9	23	67	200
4	1.0	19	62	220
5	0.9	18	62	195
6	1.0	21	68	210
7	1.1	22	70	190
8	1.0	17	63	194
9	1.0	16	70	197
10	1.1	23	61	205

- Moniculture pilot:

Checking time	Beginning	Time 1	Time 2	Time 3
1	1.0	18	51	170
2	1.0	23	71	195
3	0.9	23	67	170
4	1.0	19	58	220
5	0.9	18	52	195
6	1.0	21	68	165
7	1.1	22	67	190
8	1.0	17	63	194
9	1.0	16	57	165
10	1.1	23	61	155

3. Growth rate of oyster

4. Survival rate of grouper

Checking time	Survival rate (%)	
	Monoculture grouper cage	Grouper-oyster cage
Time 1	57	80
Time 2	32	79
Time 3	25	85